By LESTER C. THUROW

A Fiscal Policy Model of the United States

This article is a progress report on an econometric model designed to provide long-range projections of the U.S. economy and to aid in the formulation of fiscal policies. The model, developed by Professor Thurow while at Harvard University, is still in its formative stages; OBE is planning to use the model in its analytical work and to improve and develop it further.

Most longrun models are supply oriented, while shortrun models are demand oriented. A distinctive feature of this model is its inclusion of both a supply side and a demand side, linked by a set of income flows. In addition to describing the overall design of the model, the article uses its equations to simulate the economy for the 20-year period 1948–67 under actual unemployment conditions and under an assumed path of steady full employment. Another set of simulations examines the sensitivity of the economy to changes in the various fiscal policy instruments found throughout the model.

THIS is a progress report on an econometric model designed to provide long-term projections of the U.S. economy and to aid in formulating economic policies that will achieve given unemployment or growth targets.[1] The model concentrates on fiscal policies. It includes interest rates among the policy tools available to the Government, but otherwise does not permit an analysis of nonfiscal economic policies. The model is in its formative stage; it is not yet a reliable policy tool.

Summary Description of Model

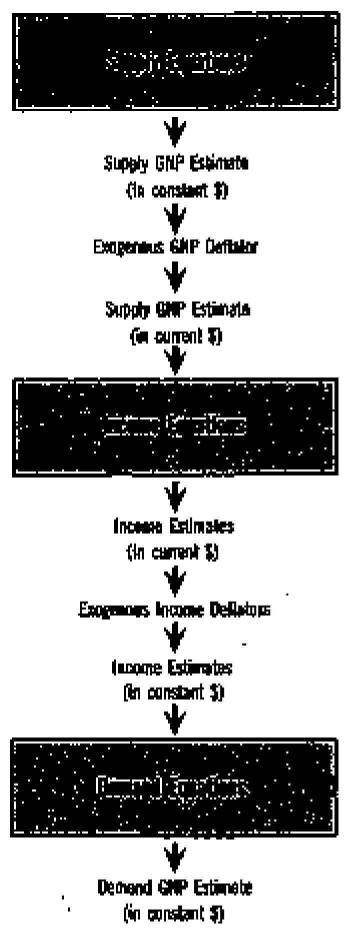
The economic process can be thought of as a complex, systematic interaction of numerous economic forces. An econometric model is an attempt to express this process in terms of mathematical equations. No mathematical model can hope to duplicate reality, because a finite number of equations must be used to represent an infinity of economic relationships. Hence, a model must focus on the relationships that are quantitatively important. Statistical techniques are used to isolate these relationships and to express them numerically.

In designing an econometric model, there is wide latitude as to the number of economic interrelationships that can be taken into account. This model consists of about 30 equations. It has been kept small so as to make it easier to understand and to manipulate. At a later date, the model may be enlarged in directions suggested by its practical use. Since it is a fiscal policy model, an attempt has been made to show explicitly as many of the major fiscal policy variables as possible. The model has also been designed to facilitate the elimination of specific equations and the substitution for them of other equations or estimates. Such flexibility is a distinct advantage, given the serious limitations in our ability to select by objective, scientific processes the equations that best reflect the underlying economic relationships.

Not all economic variables are determined within the model. Some are "exogenous," i.e., introduced from the outside. In the present model, these include population, exports, prices, and variables that are directly responsive to Government policy decisions (e.g., tax rates, Government expenditures, and interest rates). Other variables are "endogenous," i.e., determined within the model. If values for the exogenous variables are inserted into the model, it produces estimates of the endogenous variables. In the present model, endog-

CHART 10

Simplified Flow Diagram of Model



In equilibrium: Demand GNP (in constant $) = Supply GNP (in constant $)

U.S. Department of Commerce, Office of Business Economics

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1. The work on this model was financed by the Interagency Growth Study through a research contract with the Office of Business Economics, U.S. Department of Commerce. The author benefited from the comments of many individuals within and outside the Government.

If this is the first econometric model the reader has encountered, an earlier report on a short-term forecasting model developed by the Office of Business Economics provides an excellent introduction to the subject. See Maurice Liebenberg, Albert A. Hirsch, and Joel Popkin, "A Quarterly Econometric Model of the United States: A Progress Report," SURVEY OF CURRENT BUSINESS, May 1966. The description of the simplified model at the beginning of the report is especially useful.

NOTE.—Dr. Thurow is Associate Professor of Economics and Management at Massachusetts Institute of Technology.

enous variables include personal consumption, investment, personal income, and corporate profits. Depending on what targets are specified, some variables may be endogenous or exogenous. If an unemployment target is exogenously set, GNP is endogenously determined within the model. If a growth target is exogenously set, unemployment is endogenously determined within the model.[2]

Supply, demand, and income equations

Traditionally, long-term econometric models have been primarily supply oriented and short-term models have been largely demand oriented. Limitations on supply have determined output in long-term models; aggregate demand has determined output in short-term models. Our model contains both a demand and a supply side. The two may not be in balance. A major objective of the model is to determine what combinations of Government policies can achieve a balance between supply and demand at unemployment or growth targets that are satisfactory to the policymaker.

The supply and demand sides of the model are linked by incomes (chart 10). Production creates incomes and incomes create demand. The supply and demand sides are estimated in constant dollars while incomes are estimated in current dollars. Exogenous price deflators are used to move from one section of the model to another. The model provides no aid in estimating these deflators. This is a major weakness, but unfortunately too little is known about long-term price behavior to quantify it in terms of mathematical equations.

The supply equations estimate the GNP that could be produced with different quantities of capital and labor. They are used to derive the GNP necessary to achieve the unemployment target.

A set of incomes is associated with every GNP that is calculated from the supply side. The total of these incomes necessarily equals the supply side GNP, but fiscal policies influence its distribution among persons, corporations, and government. The income equations of the model estimate the various components of aggregate income; they are used to derive the distribution of income that is consistent with the supply estimate of the GNP.

Given the income flows estimated from the income equations, the demand equations estimate personal consumption, private domestic investment, imports, and State and local government purchases. Federal purchases and exports are left as exogenous variables.

Summing the elements of demand provides the demand-side estimate of GNP, which need not equal the supply-side estimate. If the two are not equal, the unemployment target cannot be achieved with existing policies.

The model provides estimates of the alternative combinations of policies that could be used to achieve the desired unemployment target. If the demand-side estimate of GNP exceeds the supply-side estimate, the aggregate demand for goods and services must be reduced by raising taxes and interest rates or by lowering Federal expenditures. If the supply-side estimate exceeds the demand-side estimate, aggregate demand must be increased. Many different combinations of policies will bring the economy into equilibrium. The feasible combinations are determined by the model, but the particular set of instruments actually used will depend on the preferences of the policy maker. Value judgments are an important ingredient in choosing the mix of policy instruments as well as in setting economic targets.

The following sections provide a somewhat more detailed description of the supply, income, and demand sides of the model.

The supply side

The supply equations are used to estimate the GNP necessary to achieve the unemployment target. The size of the labor force, its division between public and private employment, the size of the capital stock, and the level of productivity all influence the supply

Table 1.—Derivation of Disposable Personal Income From GNP

	Actual 1965 values, billion $	Derivation of model estimates
Total GNP	684.9	Equation (13)*
Less: Capital consumption allowances	59.8	
Corporate	36.4	Equation (7)*
Noncorporate	23.4	Equation (14)*
Less: Indirect business taxes	62.5	
Federal	16.5	Equation (16)
State and local	46.0	Equation (15)
Less: Corporate profits and IVA	76.1	Equation (9) (plus exogenous IVA)
Plus: Dividends	19.8	Equation (24)
Less: Contributions for social insurance	29.6	
Federal:		
OASDHI	17.8	Equation (18)
Unemployment	3.7	Equation (19)
Other	3.7	Exogenous
State and local	4.5	Equation (17)
Plus: Interest	20.5	
Paid by Federal Government	8.7	Equation (20)
Paid by State and local government	.5	Exogenous
Paid by consumers	11.3	Equation (22)
Plus: Government transfers	37.2	
Federal	30.3	Exogenous
State and local	6.9	Exogenous
Plus: Subsidies less current surplus of government enterprises	1.3	
Federal	4.3	Exogenous
State and local	−3.0	Exogenous
Less: Statistical discrepancy	−3.1	Assumed to be zero
Less: Personal taxes	65.7	
Federal	53.9	Equation (26)
State and local	11.8	Equation (27)
Equals: Disposable personal income	473.2	Residual

*Converted to current dollars.

Source: U.S. Department of Commerce, Office of Business Economics.

2. In the rest of this article, the model is explained in terms of setting unemployment rather than growth targets.

estimate of GNP. Government policies affect many of these items.

The first step in estimating the supply-side GNP is the calculation of the labor force consistent with the unemployment target. Given exogenous estimates of population by age and sex, participation functions are used to determine the proportions of the population that will enter the labor force. Since decisions to enter the labor force are dependent on the probability of finding work, the size of the labor force will in part depend on the unemployment target. The lower the target, the larger the labor force that must be employed.

Next come the estimations of Federal employment and State and local government employment. Government employment is estimated separately for two reasons. First, Federal employment is one of the major policy instruments of the Federal Government. Second, gross product originating in the government is measured according to national economic accounting conventions, which makes it necessary to distinguish government employment in the estimating process.[3]

Subtracting the target unemployment and government employment from the labor force yields private employment. Because labor input is a function of hours worked as well as of the number of employees, an equation is introduced to translate private employment into private man-hours.

Since capital inputs as well as labor inputs are necessary to estimate GNP, the second major step in estimating GNP is to calculate the gross capital stock, which is taken as the measure of capital inputs. Given the capital stock of the previous year, investment and discards must be estimated to determine the current capital stock. Discards are determined exogenously, but investment depends, among other things, on the level of private GNP and the flow of corporate internal funds. For this reason, the supply side of the model contains equations not only for investment demand but also for corporate profits, capital consumption allowances, and taxes, the income flows that determine the level of internal funds. Government policies can influence the size of the capital stock, via internal funds, by alterations in the corporate tax rate and depreciation guidelines.

The equations for investment, private GNP, and corporate funds are interrelated. Investment depends on internal funds, which depend upon the level of private GNP, which in turn depends upon the size of the current capital stock. Consequently, these equations must be solved simultaneously.

The third step in calculating GNP is to translate man-hours and the capital stock into estimates of private GNP. A production function is used for this purpose. In addition to estimating increases in GNP that would result from increases in capital and labor, this function takes into account the impact of technical progress. To allow for technical progress, the production function provides for improvements in the skill and training of the labor force (embodied technical progress in labor), greater efficiency of the capital stock (embodied technical progress in investment), and more efficient organization of men and machines (disembodied technical progress). Over time, technical progress increases the amount of output per unit of input.

In the long run, the growth of productivity can be influenced by private and public policies in education, manpower training, and research and development. However, the connection between such policies and the rate of technical progress must be determined outside of the model.

Since, according to the existing conventions, government output is equal to the labor input of government employees, a government production function is not necessary. Estimates of government employment are valued at base period rates of compensation to provide the measure of the government contribution to GNP. Government GNP plus private GNP equals the supply-side estimate of total GNP.

The income equations

The various income equations, together with exogenous estimates of transfer payments, subsidies, and grants-in-aid, permit one to determine the distribution of income that is consistent with the supply-side estimate of GNP. There are separate equations for noncorporate capital consumption allowances, indirect business taxes, social insurance contributions, government and consumer interest payments, dividends, and personal tax payments. (Corporate profits, taxes, and capital consumption allowances have already been determined from equations on the supply-side of the model.)

When the appropriate income elements, both exogenous and endogenous, are added and subtracted from the supply-side estimate of GNP, disposable personal income is derived as a residual (table 1). Incomes of the other sectors are also estimated by combining appropriate flows derived from the income equations and exogenous estimates. The sum of the disposable incomes of the various sectors necessarily equals the supply-side estimate of GNP.

Variables under the control of the Federal Government are found throughout the various income equations. These consist of corporate and personal income tax rates, social insurance tax bases and rates, Government interest rates, and indirect business tax rates. Changes in any of these variables can affect the distribution of incomes among the various sectors of the economy.

The demand side

The demand equations estimate personal consumption expenditures, residential investment, inventory change, imports, and State and local government purchases (other than compensation of employees). Investment in nonresidential structures and equipment and the compensation of State and local government employees are estimated in equations on the supply side. The remaining elements of final demand—exports and Federal Government purchases—are left as exogenous variables. Exports are estimated exog-

3. Gross government product is measured in terms of the value of labor input only; the contribution of capital used by the government is not taken into account. Also, it is assumed that the productivity of government employees is constant over time; productivity increases are not allowed for. These procedures cause gross product per government employee to differ from gross product per private employee. As a result, the distribution of employment between the private and public sector affects the size of the supply-side estimate of GNP and must be taken into account.

enously because they depend primarily on foreign economic conditions. Federal Government purchases are a major policy variable operating directly on demand.

Most other policy variables have their principal impact on aggregate demand indirectly through their effects on incomes. Personal, social insurance, and indirect business taxes and transfer payments affect disposable personal income and hence personal consumption expenditures, residential investment, and imports. Corporate tax and depreciation policies affect corporate incomes and hence investment in nonresidential structures and equipment, but they also influence personal consumption through their effects on dividends and personal income.

Grants-in-aid influence State and local purchases, and interest rates influence residential investment.

Balancing supply and demand

Summation of the component demands for goods and services—exogenous and endogenous—yields the demand-side estimate of GNP. The demand- and supply-side estimates of GNP may not agree. Although the sum of disposable sector incomes necessarily equals the supply-side estimate of the GNP, demand for GNP will fall short of or exceed the supply of GNP unless the total purchases of the various sectors happen to equal their combined disposable incomes.

The gap between the supply- and demand-side estimates depends in part on the Government policies incorporated in the model. If there is a gap, the target unemployment rate cannot be achieved unless Government policies are altered. The Government may change its own demand for goods and services or alter grants-in-aid, corporate or personal income taxes, indirect business taxes, social insurance taxes, transfer payments, or interest rates so as to change private or State and local demand. Many combinations of these policies are possible. The choice among them must be made on the basis of considerations that are outside the model.

It should be noted that the gap between the supply and demand estimates of GNP as shown by this model is not the familiar gap calculated in recent reports of the Council of Economic Advisers. The CEA gap is bweteen the "potential" GNP—i.e., the GNP consistent with full employment—and actual GNP. The gap in this model is between potential GNP and the GNP that would be demanded at the incomes generated by an economy achieving this potential.

To isolate the crucial difference between these two kinds of gaps, assume that the potential GNP estimated by the CEA is based on the same unemployment rate as the one assumed in the supply estimate of this model, so that the two GNP estimates are the same. Suppose now that the model shows a positive gap (the supply-side estimate exceeding the demand-side estimate of GNP), because the demand generated by the incomes consistent with the supply-side estimate of GNP falls short of the supply of GNP. In this situation, the gap as defined by the CEA would be larger: Actual GNP would be smaller than the demand-side estimate of GNP produced by the model because of the downward adjustment set in motion by the initial imbalance. The lower demand-side GNP would call forth a smaller supply-side GNP, which in turn would result in lower incomes, which in turn would generate lower demand GNP. The process would continue until supply and demand were in balance.

The Equations

This section describes the equations; the actual equations appear with their statistical properties in the appendix. Readers not interested in the details of the model may omit this section.

Supply equations

Labor force participation (equation 1) is estimated separately for males and females. It depends on the probability of finding employment and a time trend. However, this usual type of participation function is modified in two ways. First, because of the limited number of potential male workers outside of the labor force, male participation rates respond to employment opportunities nonlinearly. The number of males attracted into the labor force for each successive percentage point decline in the unemployment rate falls as the employment rate rises. Since the pool of potential female workers is much larger than that of males, this nonlinearity does not appear in the participation function for females. Second, participation rates for both males and females depend on changes in employment as well as on the employment rate. Hence, the equilibrium participation rates will differ from the participation rates during years of changing employment.

State and local government employment per capita (equation 2) depends upon per capita private output (lagged 1 year), school enrollment, and grants-in-aid. Per capita private GNP represents the influence of income on the demand for public goods; per capita school enrollment is a direct measure of the demand for State and local educational services, and per capita grants-in-aid primarily reflect the financial capability to purchase the services of government employees.

Average annual hours per private employee (equation 3) depend upon the unemployment rate and a time trend. The unemployment rate reflects the cyclical responsiveness of annual hours worked. The time trend reflects the long-run tendency toward a shorter workweek and longer vacations with more paid holidays. The time trend is modified beginning with 1957. By 1957, the movement to a standard 40-hour workweek had been accomplished, and the annual decline in hours worked was markedly reduced.

Fixed nonresidential investment is determined in two equations, one for producers' durable equipment (equation 4) and one for structures (equation 5). Equipment investment depends on private GNP, the internal flow of funds available for investment (deflated by the investment deflator), the existing stock of equipment, and the interaction between capacity utilization and profitability as measured by the previous year's ratio of internal funds to the capital stock. To permit timelags in the investment response, equipment investment from the preceding period is included as an explanatory variable.

An interaction term is necessary to capture the reinforcing effects of high profitability and high utilization. The two conditions together lead to higher investment than is produced by the sum of their separate effects. Investment in nonresidential structures depends on the previous year's rate of return on the capital stock, private GNP, and investment from the previous period. The long service life of nonresidential structures makes the existing capital stock unimportant in determining this investment. Since external rather than internal funds are an important source of financing investment in structures, internal funds did not prove to be a significant variable in this equation.

Corporate internal funds are determined by three equations. Equation 6 estimates the gross flow of corporate funds—corporate capital consumption allowances plus book profits before taxes. Equation 7 estimates corporate capital consumption allowances, and equation 8 estimates Federal corporate profits taxes. The gross flow of funds depends on private GNP, the utilization of capacity (measured by the unemployment rate), and relative movements in the private GNP deflator, and the cost of labor per unit of output. Changes in the relationship between labor costs and prices are an important determinant of profits. A 1 percent increase in the price of private GNP relative to the change in unit labor costs raises the flow of corporate funds by $1.4 billion.

Corporate capital consumption allowances depend upon the stock of capital. They are affected by the 1954 change in the tax law and the introduction in 1962 of new IRS guidelines for depreciation practices. Federal corporate profits taxes are explained by the corporate tax rate and corporate profits. State and local corporate profits taxes are exogenous. Equations 9 and 10 give the identities for corporate profits and internal funds.

The production function (equation 11), which determines private GNP, has terms for capacity utilization, measured by the unemployment rate, labor input, capital stock, disembodied technical progress, and embodied technical progress in both capital and labor. The capacity utilization variable is nonlinear; as employment increases, output per man-hour also increases but by diminishing amounts. One percent per year was chosen as the rate of embodiment in labor; 4 percent per year as the rate of embodiment in gross investment. Functions with these specifications enjoy a slight statistical superiority, but the choice must ultimately be based on external evidence.[4]

A production function specified in the foregoing manner yields an annual rate of growth of disembodied technical progress of 1.17 percent, an elasticity of output with respect to labor of 0.83, and an elasticity of output with respect to capital of 0.17. When this production function is used to estimate GNP for the period from 1929 to 1965, the differences between the actual and esti-

4. For a detailed discussion of the choice of production function, see Lester C. Thurow and L. D. Taylor, "The Interaction Between the Actual and the Potential Rates of Growth," *The Review of Economics and Statistics*, November 1966.

CHART 11

Private GNP—Actual and Estimated From Production Function, 1929-65

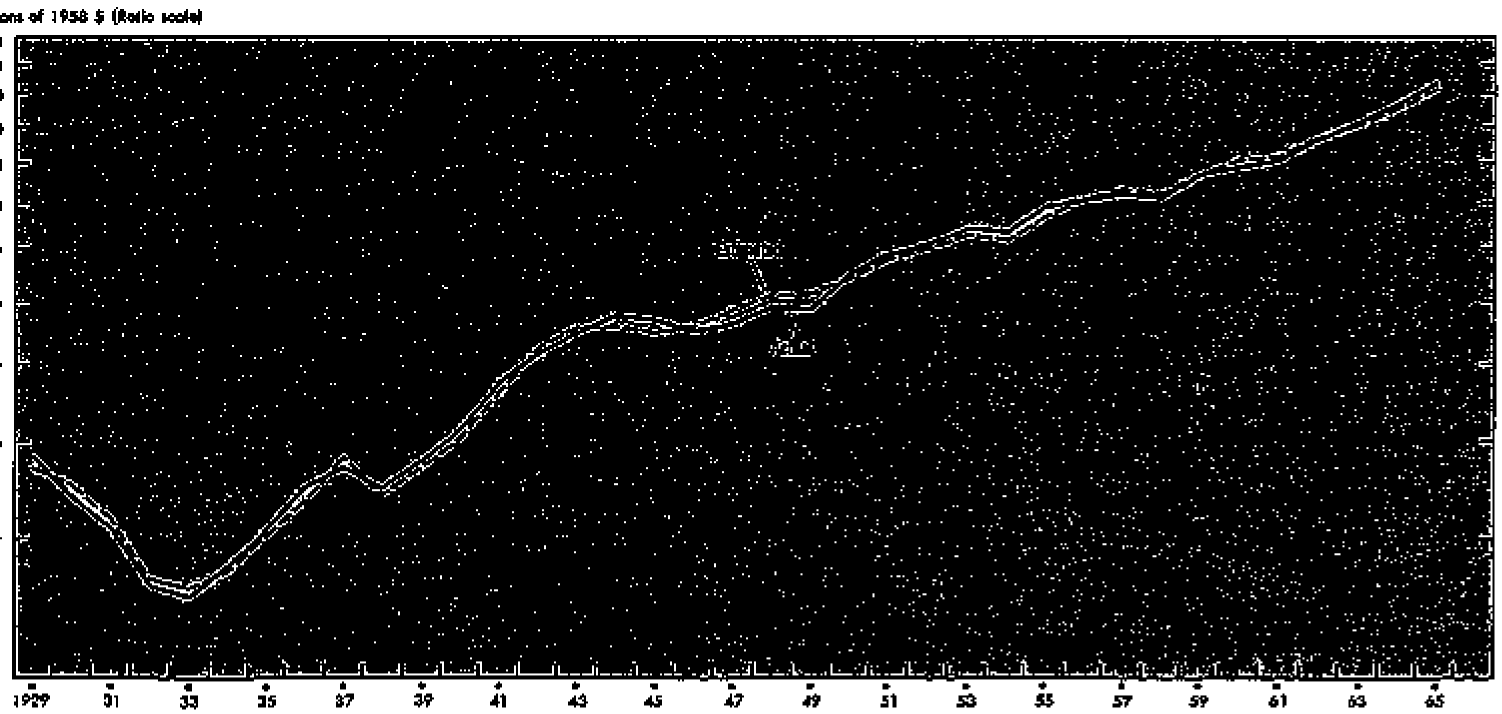

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Table 2.—Estimated and Actual Values: Selected GNP Components and Related Items, 1948–67

	Gross national product				Index of total private man-hours [1]			
	Estimated	Actual	Difference (1)−(2)	(3)÷(2)	Estimated	Actual	Difference (5)−(6)	(7)÷(6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(Billions of 1958 $)			(Percent)	(1958=100)			(Percent)
1948	336.1	323.7	12.4	3.8	104.6	104.0	0.6	0.6
1949	335.8	324.1	11.7	3.6	100.8	101.3	−.5	−.5
1950	350.7	355.3	−4.6	−1.3	102.0	102.3	−.3	−.3
1951	376.9	383.4	−6.5	−1.7	105.8	106.0	−.2	−.2
1952	391.4	395.1	−3.7	−.9	105.8	105.5	.3	.3
1953	406.3	412.8	−6.5	−1.6	105.0	103.9	1.1	1.1
1954	399.0	407.0	−8.0	−2.0	100.3	99.8	.5	.5
1955	419.9	438.0	−18.1	−4.1	103.0	103.8	−.8	−.8
1956	438.4	446.1	−7.7	−1.7	104.0	105.0	−1.0	−.9
1957	455.0	452.5	2.5	.6	104.8	103.6	1.2	1.1
1958	445.6	447.3	−1.7	−.4	100.6	101.0	−.4	−.4
1959	472.2	475.9	−3.7	−.8	104.6	104.8	−.2	−.2
1960	491.5	487.7	3.8	.8	105.1	105.2	−.1	−.1
1961	498.4	497.2	1.2	.2	103.5	104.4	−.9	−.9
1962	528.7	529.8	−1.1	−.2	105.4	105.0	.4	.4
1963	548.3	551.0	−2.7	−.5	107.0	106.7	.3	.3
1964	577.7	581.1	−3.4	−.6	109.5	109.0	.5	.6
1965	612.5	617.8	−5.3	−.9	112.7	112.3	.4	.4
1966	650.3	657.1	−6.8	−1.0	115.3	114.4	.9	.8
1967	683.8	673.1	10.7	1.6	117.2	114.6	2.6	2.3
Annual average*			6.1	1.4			.7	.6

	Gross stock of equipment & structures				Disposable personal income			
	Estimated	Actual [2]	Difference (9)−(10)	(11)÷(10)	Estimated	Actual	Difference (13)−(14)	(15)÷(14)
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	(Billions of 1958 $)			(Percent)	(Billions of current $)			(Percent)
1948	389.4	388.7	0.7	0.2	193.4	189.1	4.3	2.3
1949	406.7	404.0	2.7	.7	191.7	188.6	3.1	1.6
1950	423.5	421.5	2.0	.5	207.9	206.9	1.0	.5
1951	441.1	440.1	1.0	.2	224.8	226.6	−1.8	−.8
1952	457.6	455.9	1.7	.4	237.4	238.3	−.9	−.4
1953	473.1	472.5	.6	.1	251.8	252.6	−.8	−.3
1954	485.5	487.7	−2.2	−.5	254.8	257.4	−2.6	−1.0
1955	499.1	506.0	−6.9	−1.4	268.2	275.3	−7.1	−2.6
1956	513.9	526.9	−13.0	−2.5	292.4	293.2	−.8	−.3
1957	529.4	546.5	−17.1	−3.1	312.1	308.5	3.6	1.2
1958	542.2	559.3	−17.1	−3.1	317.0	318.8	−1.8	−.6
1959	557.5	574.4	−16.9	−2.9	335.3	337.3	−2.0	−.6
1960	575.3	592.5	−17.2	−2.9	352.2	350.0	2.2	.6
1961	593.1	607.9	−14.8	−2.4	365.9	364.4	1.5	.4
1962	614.5	626.6	−12.1	−1.9	386.2	385.3	.9	.2
1963	638.1	646.2	−8.1	−1.3	403.6	404.6	−1.0	−.2
1964	666.1	670.7	−4.6	−.7	431.5	438.1	−6.6	−1.5
1965	698.7	702.8	−4.1	−.6	465.8	473.2	−7.4	−1.6
1966	733.0	740.5	−7.5	−1.0	499.2	511.6	−12.4	−2.4
1967	773.8	776.8	−3.0	−.4	545.3	546.3	−1.0	−.2
Annual average*			7.8	1.4			2.2	1.0

	Corporate internal funds				Federal Government receipts			
	Estimated [3]	Actual [4]	Difference (17)−(18)	(19)÷(18)	Estimated [5]	Actual	Difference (21)−(22)	(23)÷(22)
	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	(Billions of current $)			(Percent)	(Billions of current $)			(Percent)
1948	28.2	27.5	0.7	2.5	45.5	43.3	2.2	5.1
1949	30.8	28.3	2.5	8.8	44.1	38.9	5.2	13.4
1950	26.8	28.6	−1.8	−6.3	49.4	49.9	−.5	−1.0
1951	32.2	30.6	1.6	5.2	61.3	64.0	−2.7	−4.2
1952	34.7	32.1	2.6	8.1	64.4	67.2	−2.8	−4.2
1953	33.3	32.5	.8	2.5	66.5	70.0	−3.5	−5.0
1954	33.3	35.2	−1.9	−5.4	64.3	63.8	.5	.8
1955	38.3	42.7	−4.4	−10.3	69.6	72.1	−2.5	−3.5
1956	38.7	43.4	−4.7	−10.8	74.2	77.6	−3.4	−4.4
1957	44.2	45.3	−1.1	−2.4	80.5	81.6	−1.1	−1.4
1958	45.1	44.1	1.0	2.3	80.7	78.7	2.0	2.5
1959	49.8	51.4	−1.6	−3.1	89.2	89.7	−.5	−.6
1960	52.9	51.8	1.1	2.1	95.4	96.5	−1.1	−1.1
1961	54.1	53.2	.9	1.7	99.0	98.3	.7	.7
1962	62.2	61.7	.5	.8	106.4	106.5	−.1	−.1
1963	64.9	64.4	.5	.8	113.2	114.5	−1.3	−1.1
1964	71.3	71.9	−.6	−.8	117.4	115.0	2.4	2.1
1965	78.7	81.1	−2.4	−3.0	124.4	124.7	−.3	−.2
1966	87.1	89.0	−1.9	−2.1	143.4	143.0	.4	.3
1967	93.0	90.3	2.7	3.0	154.0	151.2	2.8	1.9
Annual average*			1.8	4.1			1.8	2.7

	State and local government receipts				Personal consumption expenditures			
	Estimated [6]	Actual	Difference (25)−(26)	(27)÷(26)	Estimated	Actual	Difference (29)−(30)	(31)÷(30)
	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
	(Billions of current $)			(Percent)	(Billions of 1958 $)			(Percent)
1948	17.8	17.6	0.2	1.1	217.2	210.8	6.4	3.0
1949	17.9	19.3	−1.4	−7.3	219.3	216.5	2.8	1.3
1950	19.9	21.1	−1.2	−5.7	230.9	230.5	.4	.2
1951	23.9	23.3	.6	2.6	235.6	232.8	2.8	1.2
1952	25.0	24.3	.7	2.8	243.0	239.4	3.6	1.5
1953	28.1	27.2	.9	3.3	253.2	250.8	2.4	1.0
1954	28.5	28.8	−.3	−1.0	256.5	255.7	.8	.3
1955	31.5	31.4	.1	.3	266.9	274.2	−7.3	−2.7
1956	35.0	34.7	.3	.9	282.2	281.4	.8	.3
1957	39.3	38.2	1.1	2.9	293.6	288.2	5.4	1.9
1958	41.4	41.6	−.2	−.5	296.4	290.1	5.3	1.8
1959	46.6	46.0	.6	1.3	306.4	307.8	−1.4	−.5
1960	49.7	49.9	−.2	−.4	316.6	316.1	.5	.2
1961	52.5	53.6	−1.1	−2.1	325.4	322.5	2.9	.9
1962	57.5	58.6	−1.1	−1.9	338.7	338.4	.3	.1
1963	63.4	64.4	−1.0	−1.6	350.3	353.3	−3.0	−.9
1964	68.7	69.5	−.8	−1.2	367.9	373.7	−5.8	−1.6
1965	75.4	75.5	−.1	−.1	390.2	397.7	−7.5	−1.9
1966	85.9	84.6	1.3	1.5	409.8	417.8	−8.0	−2.1
1967	93.9	91.9	2.0	2.2	433.8	430.5	3.3	.8
Annual average*			.9	2.0			3.6	1.3

mated values of private GNP are small (chart 11). The largest errors appear during the postwar readjustment from 1947 to 1949.

The equations for investment, internal funds, and private GNP (equations 4–11) are interdependent in the sense that the solution to one equation depends on the solution to the others. Iterative techniques produce quick solutions for the set of equations. Starting from an initial estimate of private GNP and using the error produced by the initial estimate to refine the second estimate, one can find the correct solutions in two or three iterations.

Gross government product (equation 12) is determined from a set of identities that multiplies government employment by average compensation per employee in 1958.

The supply-side estimate of GNP (equation 13) is the sum of private and government GNP.

Income equations

Noncorporate capital consumption allowances (equation 14) depend upon the housing stock as the principal explanatory variable. The housing stock multiplied by a time trend is used as an additional explanatory variable.

Table 2.—Estimated and Actual Values: Selected GNP Components and Related Items, 1948–67—Continued

	Fixed nonresidential investment				Residential investment				State and local government purchases			
	Estimated (33)	Actual (34)	Difference (33)−(34) (35)	(35)÷(34) (36)	Estimated (37)	Actual (38)	Difference (37)−(38) (39)	(39)÷(38) (40)	Estimated (41)	Actual (42)	Difference (41)−(42) (43)	(43)÷(42) (44)
	(Billions of 1958 $)			(Percent)	(Billions of 1958 $)			(Percent)	(Billions of 1958 $)			(Percent)
1948	38.6	38.0	0.6	1.6	17.0	17.9	−0.9	−5.0	24.7	22.7	2.0	8.8
1949	36.6	34.5	2.1	6.1	18.3	17.4	.9	5.2	26.0	25.7	.3	1.2
1950	36.8	37.5	−.7	−1.9	20.1	23.5	−3.4	−14.5	26.4	27.5	−1.1	−4.0
1951	38.6	39.6	−1.0	−2.5	19.9	19.5	.4	2.1	27.8	27.9	−.1	−.4
1952	39.0	38.3	.7	1.8	18.9	18.9	0	0	28.5	28.4	.1	.4
1953	39.6	40.7	−1.1	−2.7	19.1	19.6	−.5	−2.6	30.5	29.7	.8	2.7
1954	36.9	39.6	−2.7	−6.8	20.1	21.7	−1.6	−7.4	32.2	32.1	.1	.3
1955	39.2	43.9	−4.7	−10.7	24.7	25.1	−.4	−1.6	33.3	34.4	−1.1	−3.2
1956	41.2	47.3	−6.1	−12.9	23.1	22.2	.9	4.1	35.5	35.6	−.1	−.3
1957	43.1	47.4	−4.3	−9.1	21.2	20.2	1.0	5.0	38.1	37.6	.5	1.3
1958	41.8	41.6	.2	0.5	19.0	20.5	−1.5	−7.2	41.1	40.6	.5	1.2
1959	44.1	44.1	0	0	23.9	24.7	−.8	−3.2	43.0	42.2	.8	1.9
1960	46.7	47.1	−.4	−.8	18.9	21.9	−3.0	−13.7	44.6	43.5	1.1	2.6
1961	47.9	45.5	2.4	5.3	21.2	21.6	−.4	−1.9	46.8	45.9	.9	2.0
1962	52.3	49.7	2.6	5.2	24.6	23.8	.8	3.4	48.0	47.5	.5	1.1
1963	56.1	51.9	4.2	8.1	25.5	24.8	.7	2.8	51.0	50.1	.9	1.8
1964	60.8	57.8	3.0	5.2	26.1	24.2	1.9	7.9	53.5	53.2	.3	.6
1965	66.6	66.3	.3	.5	26.5	23.8	2.7	11.3	56.4	56.8	−.4	−.7
1966	72.8	73.8	−1.0	−1.4	27.2	21.1	6.1	28.9	61.0	61.3	−.3	−.5
1967	77.2	73.6	3.6	4.8	24.5	19.9	4.6	23.1	63.5	65.9	−2.4	−3.6
Annual average*			2.1	4.4			1.6	7.5			.7	1.9

*Without regard to signs.
1. Labor force concept.
2. As published in the February 1967 SURVEY. This series has undergone extensive revision. The latest data on fixed business capital stock are available in the February 1969 SURVEY. However, the earlier series was used in the various estimating equations.
3. Estimated from equation (6) minus equation (8) minus exogenous State and local corporate profit taxes plus exogenous inventory valuation adjustment.
4. Corporate profits after taxes plus inventory valuation adjustment and corporate capital consumption allowances.
5. The sum of the estimates from equation (8), (16), (18), (19), and (38), plus exogenous contributions for other Federal social insurance programs.
6. The sum of the estimates from equations (15), (16), and (27), plus exogenous Federal grants-in-aid.

Source: U.S. Department of Commerce, Office of Business Economics.

Indirect business taxes are determined by two equations, one for State and local (equation 15) and one for Federal Government (equation 16). Because individual tax rates (except for the motor fuel tax) are not shown separately, the effects of changes in individual excise tax rates cannot be determined within the model. State and local indirect business taxes are a simple function of private GNP. State and local indirect business tax rates have been rising, but their tax bases do not expand as fast as GNP. Consequently, the net effect has been to keep State and local indirect business taxes a constant percentage of GNP. Federal indirect business taxes are a function of private GNP, motor fuel usage, the tax rate on motor fuels, and a dummy variable to reflect changes in indirect business taxes during the Korean war period.

Contributions for social insurance are split into four types, State and local programs (equation 17), old age, survivors, and disability insurance (OASDHI, equation 18), unemployment insurance (equation 19), and other Federal programs (mainly pension contributions for Federal employees and veterans' life insurance contributions). There are separate equations for the first three items. The fourth is exogenous since it is related to Federal Government employment, which is also exogenous.

In the equation for contributions for State and local social insurance programs, the compensation of State and local government employees (net of employers' contributions for social insurance) is the major explanatory variable since this category refers mainly to pension plans for State and local government employees. The other explanatory variable is lagged State and local social insurance contributions. The OASDHI equation depends on the combined tax rate for employers and employees, the percentage of total employees covered, the size of the tax base as compared with median family income, and the compensation of employees (net of employers' contributions for social insurance). Compensation of employees (net) and the employers' tax rates determine unemployment insurance contributions. Compensation of employees is determined by equation 20 and employer contributions for social insurance by equation 21.

Consumer interest payments (equation 22) are adequately explained by personal income. This implies that consumers adjust their borrowing plans in order to limit interest payments to some constant fraction of their personal income. Effective rates of interest on time payments are so far above market rates of interest that changes in Government monetary policies do not seem to have any impact on consumer borrowing and interest payments.

Federal interest payments (equation 23) are a function of interest rates, the publicly held Federal debt, and lagged interest payments. State and local government interest payments are left as an exogenous variable since they are minute and stable.

Dividends (equation 24) are estimated from an equation that is a modification of one developed by Lintner.[5] Internal

5. John Lintner, "Distribution of Incomes of Corporations Among Dividends, Retained Earnings, and Taxes," *American Economic Review*, May 1956.

funds net of investment and lagged dividends are the explanatory variables. Business policies to stabilize dividends are reflected in a coefficient for the previous year's dividends that is close to unity. However, in determining dividends, firms look not only at past dividend levels and present earnings but also at investment. Higher investment leads to smaller increases in dividends since the funds are needed for investment.

Personal income is determined by equation 25 in the manner outlined in table 1.

Median family income (equation 26) is a function of the employment rate, GNP per worker, and the share of GNP going to personal income.

The equations for social insurance contributions, compensation of employees, median family income, consumer interest payments, and personal income are interdependent in that the solution to one equation depends upon the solutions to the others. They are solved by iterative techniques. The iteration is begun by assuming initial estimates of social insurance contributions and consumer interest payments that then permit an initial estimate of personal income. Successive iterations correct for differences between the derived estimates of social insurance contributions and consumer interest payments and the initial assumptions as to their magnitudes.

Table 3.—Residual and Actual Values of Federal Government Purchases, 1948–67

	Federal Government purchases of goods and services (except compensation)			
	Residual [1]	Actual	Difference (1)−(2)	(3)÷(2)
	(1)	(2)	(3)	(4)
	(Billions of 1958 dollars)			(Percent)
1948	8.6	9.4	−0.8	−8.5
1949	20.2	12.6	7.6	60.3
1950	11.0	9.7	1.3	13.4
1951	16.8	24.5	−7.7	−31.4
1952	31.8	38.3	−6.5	−17.0
1953	38.6	45.4	−6.8	−15.0
1954	31.0	33.7	−2.7	−8.0
1955	25.3	28.6	−3.3	−11.5
1956	24.6	26.0	−1.4	−5.4
1957	32.3	30.2	2.1	7.0
1958	28.0	33.0	−5.0	−15.2
1959	29.6	32.3	−2.7	−8.4
1960	37.6	31.0	6.6	21.3
1961	31.7	34.0	−2.3	−6.8
1962	33.9	38.2	−4.3	−11.3
1963	33.7	37.9	−4.2	−11.1
1964	35.5	35.5	0	0
1965	37.2	36.1	1.1	3.0
1966	37.1	41.2	−4.1	−10.0
1967	50.2	49.0	1.2	2.4
Annual average*			3.6	13.4

*Without regard to signs.

1. Derived by subtracting from the supply-side estimate of GNP the sum of the model estimates of personal consumption expenditures, fixed investment, imports, State and local government purchases of goods and services, and the actual values for exports, Federal Government compensation, and inventory change.

Source: U.S. Department of Commerce, Office of Business Economics.

State and local personal taxes (equation 27) depend on personal income and lagged taxes. As incomes rose, the effective tax rate fell as a percentage of personal income since incomes subject to State and local income taxes did not keep pace with the growth of personal income during the period covered. Consequently, the time trend in the equation is negative.

Federal personal taxes (equation 28) also depend on personal income. Given the progressive structure of the Federal tax, the average effective tax rate rises with income. To build progression into the equation, the nominal tax rate for the median family income is included. Thus, the tax rate in the equation rises as median family income rises even if the tax structure remains unchanged.

Demand equations

Personal consumption expenditures (equation 29) are estimated by an equation developed by Houthakker and Taylor.[6] Consumption expenditures depend on the change in disposable personal income, the lagged value of disposable personal income, and the lagged value of personal consumption expenditures. With the equation containing both the change in disposable income and the previous level of disposable income, the shortrun and longrun consumption propensities may differ. The shortrun consumption propensity is 66 percent; the longrun consumption propensity is 96 percent. In a growing economy, the actual consumption propensity is a mixture of these two propensities.

Investment in residential structures (equation 30) depends on the number of households, per capita disposable income, and interest rates. Interest rates are a powerful variable in this equation. A 1 percentage point change in interest rates results in a $4.6 billion change in constant dollar residential investment. However, interest rate variables are not included prior to 1951. In the depression and in the immediate postwar period, as well as in some recent years, changes in the availability of funds were more important than variations in interest rates in determining the level of residential investment.

The equation for *change in business inventories* (equation 31) does not attempt to capture shortrun fluctuations in inventories, which are dominated by unexpected variations in both demand and supply. The model attempts to estimate desired inventory changes, which are determined by an inventory stock adjustment model, modified to allow for a time trend and a nonlinear capacity utilization variable. The latter variable helps to separate the cyclical component from the longrun growth component.

Imports of goods and services (equation 32) are based on another equation developed by Houthakker and Taylor except that lagged disposable personal income and change in disposable personal income are substituted for GNP as the variables reflecting aggregate demand. Disposable personal income seems to be a more effective explanatory variable than GNP during periods of rapid growth. The shortrun income effects are larger than the longrun effects. The longrun import propensity is 7.9 percent of disposable personal income while the shortrun propensity is 9.7 percent. Relative prices play an important part in this equation.

State and local government purchases of goods and services (except compensation of employees) per capita (equation 33) are a function of lagged per capita private GNP, per capita grants-in-aid, and school enrollment as a proportion of the total population.

The demand-side estimate of GNP is obtained from equation 34.

Simulation With the Model

Three sets of simulations are undertaken to facilitate an understanding of

6. H. S. Houthakker and Lester D. Taylor, *Consumer Demand in the United States, 1929–1970*, Harvard University Press, 1966.

how the model functions, its problems and limitations, and its implications for economic policy.

First, tests are made to evaluate the accuracy of the model, as a tool for both projecting the income and product accounts and formulating fiscal policies. To perform these tests, the economy is simulated for the period 1948–67 by inserting into the various equations of the model the actual values of all the necessary exogenous variables.

Second, the model is used to determine the differential impact on the economy of changes in each of the major fiscal policy variables. This is done by undertaking simulations in which one policy variable is altered at a time, and all others are held constant.

Third, an investigation is made of the effects on GNP of eliminating business cycles. Specifically, a constant 4 percent unemployment rate is assumed for 1948–67.

These simulations are described in detail below.

Testing the model

In order to test the accuracy of the model in projecting the GNP accounts, the unemployment rate and all other necessary exogenous variables are inserted into the equations at their actual values from 1948 to 1967. As a result, the model generates the annual time path of all the endogenous variables—both lagged and current—on the supply, income, and demand sides of the model. These estimates of the endogenous variables are compared with actual values in order to evaluate the accuracy of the model.[7]

The actual and estimated values of the most important variables are presented in table 2. In judging the errors of the model, the reader should keep in mind that the model is being subjected to a particularly severe test. It is run out over a 20-year period during which, because of the presence of numerous lagged endogenous variables, errors made in 1 year will affect the results for the next, and may very well lead to cumulative errors over the subsequent years. This test is much more stringent than the tests by which short-term forecasting models are typically judged. In these tests, actual values are substituted for the estimated values of lagged variables at intervals that usually do not exceed 1 or 2 years. Seen in this perspective, the results generated by the model both inside (1948–65) and outside (1966–67) the period of statistical estimation seem reasonably good to the author.[8]

A comparison of the actual and estimated values for constant dollar GNP provides an excellent means of evaluating the supply side of the model as a whole. The average difference between predicted and actual GNP is $6.1 billion (1.4 percent of actual GNP). The maximum error of $18.1 billion (4.1 percent) occurs in 1955, with the years 1948 and 1949 also showing relatively large percentage errors.

Differences between estimated and actual labor inputs (total private man-hours) are quite small. The average error in the man-hour estimate is about one-half of 1 percent. The only sizable error occurs in 1967 when labor input is overestimated by 2.3 percent. This overestimate stems from the fact that females did not enter the labor force at the expected rate and that average annual hours dropped more than expected.

Errors in estimating capital inputs, although larger than those for labor inputs, are also fairly small, averaging 1.4 percent per year. The largest errors—underestimates of about 3 percent—occur during the period 1957–60. They result from underestimates of business investment during the 1955–57 investment boom.

The sizable excess of estimated over actual GNP in 1948—$12.4 billion or 3.8 percent—can to a small extent be attributed to overestimates of both labor and capital inputs for that year. However, the bulk of the error is due to an overestimate of productivity. The postwar readjustment to a civilian economy was not yet complete in 1948, and disruptions attending the transition reduced actual productivity below its expected level. The $11.7 billion, or 3.6 percent, overestimate of GNP for 1949 cannot be attributed to an overestimate of factor inputs. Capital stock was overestimated by 0.7 percent, but labor input was underestimated by 0.5 percent. The model error for that year again reflects shortcomings of the production function.

The 4.1 percent error in the GNP estimate for 1955 can in part be explained by underestimates of both capital and labor inputs, but the bulk of it is due to the inability of the production function to reflect shifts in the share of durable goods in final demand.

7. Because planning horizons are longer than 1 year, perhaps averages for subperiods rather than annual data should be used to judge the model. However, subperiod averages can easily be derived from the annual data.

8. Since the equations were fitted to 1965, the comparisons for the years 1966 and 1967 provide a more stringent test of the accuracy of the model than those for the earlier years.

Table 4.—First Year Effects on Supply, Income, and Demand Resulting From Changes in Government Expenditures and Receipts Necessary to Eliminate a $1 Billion Excess of Supply Estimate of GNP Over Demand Estimate*

	Change in government expenditures and receipts	Supply effects	Income effects			Demand effects		
		Change in supply GNP	Change in disposable personal income	Change in corporate internal funds	Net change in government receipts	Change in personal demand[1]	Change in corporate demand[2]	Change in government purchases
Federal Government purchases (except compensation)	$1.0	0	0	0	0	0	0	$1.0
Indirect business taxes	−1.8	0	$1.6	0	−$1.6	$1.0	0	0
Corporate profits taxes	−3.6	$0.2	.4	$2.05	−2.0	.3	$0.9	0
Personal income taxes	−1.5	0	1.6	0	−1.6	1.0	0	0
Social insurance contributions	−1.8	0	1.6	0	−1.6	1.0	0	0
Federal employee compensation	.9	−.3	0	−.1	−.2	0	−.2	.9
Transfer payment to persons	1.8	0	1.6	0	.2	1.0	0	0
Grants-in-aid	.8	−.5	−.2	−.1	.6	−.1	−.2	.9

*These data reflect the relative prices and tax structure of the year 1967.

1. Consists of all demand elements that are dependent upon disposable personal income, i.e., personal consumption expenditures, investment in residential structures, and imports.

2. Consists of private investment in nonresidential structures, producers' durable equipment, and change in business inventories.

Source: U.S. Department of Commerce, Office of Business Economics.

Inasmuch as the production of durable goods is characterized by high output per man-hour, the pronounced shift toward durable goods that occurred in 1955 raised output in that year above the level estimated by the model. Because of this shortcoming of the production function, it might have been expected that the model would overestimate GNP in 1958, a year in which the share of durable goods in total GNP declined sharply. However, the GNP estimated by the model is quite accurate for that year, because of compensating underestimates of both capital and labor inputs.

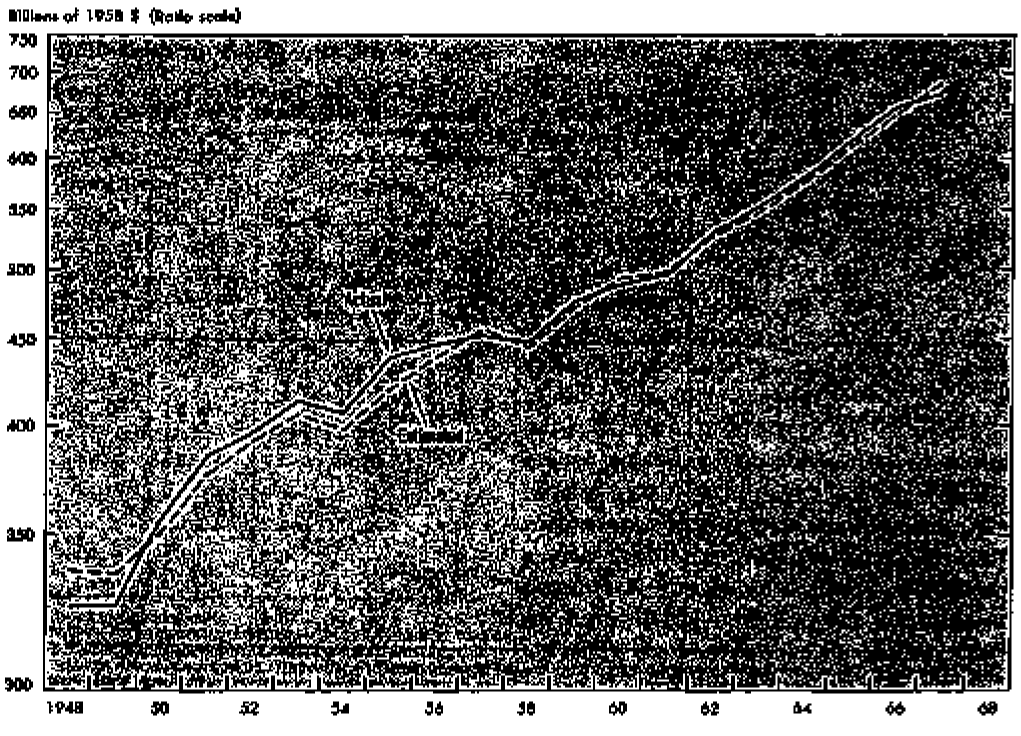
Not only does the model provide fairly accurate estimates of the level of GNP in most years, but it also reproduces the year-by-year movements in actual GNP quite closely (chart 12). Sizable errors in estimating the year-to-year changes in GNP are confined to the years 1950, 1955, 1956, 1957, and 1967. The 1950, 1955, and 1956 errors in estimating changes in GNP are associated with the model's failure to estimate properly the actual level of GNP in the preceding year. (The reasons for these failures have just been discussed.) This is not the case for 1957 and 1967. In both these years, the model overestimates the modest increase in actual GNP since it overestimates the increase in labor input.

Errors in estimating supply GNP are reflected in estimates of many of the income components, since GNP is an important explanatory variable in their estimating equations. The average errors in the income estimates are somewhat larger than those in GNP for government and corporations and somewhat smaller for persons.

The errors in estimating disposable personal income average 1.0 percent per year, with the largest errors occurring in 1948, 1955, and 1966. The direction of the errors is generally the same as for GNP. In only 3 of the 20 years—1950, 1962, and 1967—is the error in the opposite direction. The difference in direction is most marked in 1967 when disposable personal income is underestimated by $1 billion, despite a $12.4 billion overestimate of current dollar GNP. In that year, the model overestimated indirect business taxes, capital consumption allowances, and corporate profits, which are all deducted from GNP in deriving personal income.

CHART 12

GNP—Actual and Estimated From Supply Equations, 1948-67



U.S. Department of Commerce, Office of Business Economics 69-6-12

The average error in estimating corporate internal funds (defined here as after-tax profits plus IVA and capital consumption allowances) is $1.8 billion or 4.1 percent, with maximum errors of −10.3 percent in 1955 and −10.8 percent in 1956. These large errors are due only partly to supply-side errors in estimating GNP. To some extent, they also reflect errors in the other variables in the estimating equations.

Errors in estimating Federal Government receipts averaged 2.7 percent per year, with a maximum error of 13.4 percent in 1949. The 1949 error is considerably larger than the average because in that year all the errors in estimating the various tax components were in the same direction. In other years, there was some tendency for the errors to offset one another. In recessions, Federal receipts decline slightly faster than estimated, but this seems to be the only systematic error. Errors in estimating State and local government receipts average 2.0 percent per year, with a maximum of −7.3 percent in 1949.

Estimation errors on both the supply and income sides of the model are reflected on the demand side. Investment in equipment and nonresidential structures depends upon the estimates of both corporate incomes and GNP. State and local government purchases depend, among other things, upon the estimate of GNP. Disposable personal income is an important variable in determining the demands for personal consumption expenditures, imports, and residential investment.

The errors in estimating personal consumption are generally quite small, averaging 1.2 percent per year. The largest error—an overestimate of 3.0 percent—occurs in 1948. This error is associated with an overestimate of 2.3 percent in disposable personal income. In 1955, the model underestimated both personal consumption expenditures and disposable personal income by about 2.7 percent. The only other sizable error occurs in 1966 when a 2.4 percent underestimate of disposable personal income is associated with a 2.1 percent underestimate of consumption.

The average error in estimating fixed nonresidential investment is 4.4

percent, with maximum errors of over twice this amount in 1955, 1956, and 1957. The model adequately reproduces the Korean war and the 1965–66 investment booms, but it underestimates the boom of 1955–57. The sizable underestimates of 10.7 percent and 12.9 percent in 1955 and 1956 can be explained by underestimates of both GNP and internal funds. In 1957, the model underestimates investment by $4.3 billion (9.1 percent) despite the fact that GNP is slightly overestimated in that year and that the underestimate of corporate income is quite modest. From 1956 to 1957, actual output grew slowly, yet investment in plant and equipment continued at very high levels. Expectation of future growth is often used to explain this phenomenon. The model does not contain expectational variables; it depends on rising capacity utilization, profitability, and a high level of GNP to induce investment booms. Since in combination these factors were not particularly strong in 1957, the investment boom is underestimated.

The errors in residential investment are larger than those in any of the other major final demand components, averaging 7.5 percent per year. Errors are particularly large in 1966 and 1967. Residential investment is overestimated in these years because the model does not capture the effects of credit rationing.

State and local government purchases are generally well predicted, with annual errors averaging 2.1 percent. The maximum error occurs in 1948 when these purchases are overestimated by 9.3 percent. This can be attributed to the large overestimate of the previous year's GNP, which is an important variable in the equation for State and local government purchases.

While the simulations that have been discussed so far provide an appropriate test for evaluating the accuracy of the model as a tool for forecasting, they are not sufficient for testing the accuracy of the model as a tool for the planning of fiscal policies. They can, however, be expanded to provide such a test. This expansion is achieved by developing "residual" estimates of Federal Government purchases (other than compensation of employees) for 1948–67, which are then compared to actual Federal purchases for these years.[9] The residual estimates are derived by subtracting from the supply-side estimate of GNP, the sum of the model estimates of personal consumption expenditures, fixed investment, imports, State and local government purchases, and the actual values for exports, Federal Government compensation, and inventory change.[10]

The residual estimates of Federal purchases are those which, according to the model, would have been required to achieve the unemployment rates that actually prevailed in each year. If these residual purchases differ from actual purchases, the model signals that there is a gap between demand and supply and that the specified unemployment rate cannot be achieved without altering existing Government policies. Since in actuality there was no such gap, the specified unemployment rates having been achieved, this difference reflects errors in the model as a tool for planning fiscal policies.

The differences between the residual and actual values also measure the errors in the estimate of the Federal purchases required to achieve given unemployment rates. As will be seen in the next section, however, this numerical equality holds only for Federal purchases, since this is the only case where the size of the required change in Government receipts or expenditures is equal to the size of the gap.

As table 3 shows, the errors in Government purchases are reasonably small averaging $3.6 billion in 1958 dollars, but frequently large in relation to the level of Federal purchases of goods and services (except compensation of employees). After one allows for the multiplier effects, the errors in Government purchases indicate that if the model had actually been used in planning fiscal policies in the period under consideration, the unemployment targets would have been missed by small amounts in many years but by substantial amounts in 1949, 1951, 1952, 1953, and 1960.

In evaluating these errors, it should be kept in mind that, because the economy is subject to exogenous shocks, no model, even if it perfectly represents the structure of the economy, can perfectly reproduce its year-to-year movements. However, many of the observed errors in the present model are undoubtedly due to the fact that it is in the developmental stage and needs further improvement. But since all techniques of fiscal policy planning are subject to substantial errors, we feel that the present model is useful as an additional planning tool and as a check on alternative techniques.

The impact of different economic policies

As was indicated earlier, a central purpose of this model is to aid in the formulation of policies to achieve desired unemployment targets. With this in mind, simulations were undertaken to determine the magnitude of the changes in Government fiscal policies that would be required to eliminate a

Table 5.—Change in Government Expenditures and Receipts Necessary To Eliminate a $1 Billion Excess of Supply Estimate of GNP Over Demand Estimate

Government expenditures and receipts	1st year	2d year	3d year
Federal Government purchases (except compensation)	$1.0	$1.0	$1.0
Indirect business taxes	1.8	1.6	1.4
Corporate profits taxes	2.0	1.8	1.6
Personal income taxes	1.6	1.3	1.2
Social insurance contributions	1.8	1.5	1.8
Federal employee compensation	.9	.8	.6
Transfer payments to persons	1.8	1.6	1.3
Grants-in-aid	.8	.8	.8

NOTE.—Entries in the second and third columns indicate the change in government expenditures and receipts required in the given year, provided that the changes made for the previous years are those indicated in the previous columns. The data in these columns reflect the relative prices and tax structure of the year 1967.

Source: U.S. Department of Commerce, Office of Business Economics.

9. It would also have been possible to test the accuracy of the model estimates of various other policy instruments. This could have been done by reversing the usual testing procedures. Instead of forecasting endogenous variables given exogenous policy variables, endogenous variables would be set at their actual values and exogenous policy variables would be forecast. Differences between the predicted and actual values of the policy variables would provide a measure of their accuracy. However, such a test would have the disadvantage of providing no combined measure of the impact on GNP of the errors in the various individual policy instruments. Therefore, it was decided to forecast the one policy variable that does provide this overall measure, Federal Government purchases (other than compensation of employees).

10. As noted earlier, the equation for change in inventories is not designed to reflect changes associated with rapid movements in economic activity. Therefore, for this simulation, which does reflect marked annual variations in economic activity, actual rather than estimated inventory change was used.

$1 billion gap between the supply estimates of GNP consistent with the unemployment target, and the demands that would be generated by this GNP.

In these simulations, each policy instrument is altered separately to provide quantitative estimates of its impact. Knowing the different impacts, one can easily find combinations that will close a given gap. Table 4 presents the first-year effects of simulations in which each policy instrument is altered separately until it is capable of closing a $1 billion gap.[11] The various policy instruments chosen work through either Government expenditures or receipts. There is a wide range in the effectiveness of these instruments. Only a $0.8 billion change in Government grants-in-aid would be required to fill a gap of $1 billion between supply and demand, but a $3.0 billion change in corporate profits taxes would be required to accomplish the same objective.

Since Federal purchases of goods and services are a direct component of aggregate demand, a $1 billion change in Federal purchases results in a $1 billion change in aggregate demand. Thus, the change in Federal purchases necessary to close a gap between the supply and demand estimates of GNP is given by the size of the gap. However, this is not the case for the other policy instruments since they may affect supply as well as demand and since their impact on demand works indirectly via incomes. Table 4 shows how alternative policy instruments generate different impacts through their effects on the various elements of supply, income, and demand.

For instance, a cut of $3.0 billion in corporate profits taxes increases corporate incomes by $2.9 billion. This causes an increase of $0.9 billion in corporate investment. The investment increase raises the capital stock and thus increases the supply estimate of GNP by $0.2 billion. With a larger GNP and with higher dividends because of the tax cut, disposable personal income rises $0.4 billion, leading to a rise in personal demand of $0.3 billion. Thus, a $3.0 billion corporate profits tax cut results in a $1.2 billion increase in aggregate demand and a $0.2 billion increase in aggregate supply, eliminating a gap of $1 billion between supply and demand GNP.

An increase of $0.8 billion in grants-in-aid to State and local governments decreases potential GNP by $0.5 billion. This occurs for two reasons. First, an increase in grants-in-aid causes an increase in State and local government employment. The increase in the number of government employees is exactly offset by a decrease in the number of private employees, since the total of private and government employment is fixed by our estimates of the labor force and our target unemployment rate. Since the GNP per private employee is higher than that per government employee, the net effect of this shift in the composition of employment is to decrease the supply potential GNP. Second, the decrease in private GNP causes a decrease in corporate incomes, which reduces investment and capital stock and thus further contributes to the reduction in the supply estimate of GNP. The net impact that the various income changes induced by the increase in grants-in-aid have on demand is a net increase of $0.5 billion, with the $0.8 billion increase in State and local government purchases offset by small declines in personal and corporate demand. Thus, a $0.8 billion increase in grants-in-aid results in a $0.5 billion decrease in aggregate supply and a $0.5 billion increase in aggregate demand, eliminating a gap of $1 billion.

Alternative policy combinations that will eliminate a billion dollar gap can be calculated by using table 4. For example, the combination of a personal tax cut of $0.8 billion (one-half of $1.6 billion) with an increase in transfer payments of $0.9 billion (one-half of $1.8 billion) would eliminate a gap of $1 billion between supply and demand GNP as would a combined corporate tax cut of $1.5 billion and a personal tax cut of $0.8 billion.

Because of lags in economic reactions, the impact of fiscal policies depends on the time period under consideration. To close annual gaps of equal size over a number of successive years, policies must vary over time. The necessary variations can be seen in table 5. For example, if because of a cut in personal taxes, disposable personal income is increased $1.6 billion in year one,

11. These simulations were undertaken for 1967, and thus reflect the relative prices and tax structure prevailing in that year.

Table 6.—Comparison of the Model Estimates of Potential and Actual GNP, 1948–67

	Actual unemployment rate	Gross national product			Gross stock of equipment and structures			Index of total private man-hours [1]		
		4 percent unemployment	Actual unemployment	Difference (2)–(3)	4 percent unemployment	Actual unemployment	Difference (5)–(6)	4 percent unemployment	Actual unemployment	Difference (8)–(9)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		(Billions of 1958 $)			(Billions of 1958 $)			(1929=100)		
1948	3.8	382.9	388.1	−5.2	389.2	389.4	−0.1	103.2	104.5	−1.3
1949	5.9	386.1	385.8	0.3	410.0	406.7	3.3	103.2	100.8	2.4
1950	5.3	357.5	350.7	6.8	430.3	423.5	6.8	103.4	102.0	1.4
1951	3.3	368.0	376.9	−8.9	447.5	441.1	6.4	100.4	103.8	−3.4
1952	3.1	379.5	391.4	−11.9	461.9	457.6	4.3	99.8	103.8	−4.0
1953	2.9	394.0	406.3	−12.3	476.3	474.1	2.2	101.1	105.0	−3.9
1954	5.6	405.7	398.0	7.7	489.7	485.5	4.2	101.9	100.3	1.6
1955	4.4	420.1	419.9	.2	505.4	499.1	6.3	102.5	103.0	−.5
1956	4.2	434.5	438.5	−4.0	522.6	513.9	8.7	103.1	104.9	−1.8
1957	4.3	452.1	455.0	−2.9	540.9	529.4	11.5	104.3	105.8	−1.5
1958	6.8	469.7	445.6	24.1	560.1	542.2	17.9	105.3	100.6	4.7
1959	5.5	487.9	472.2	15.7	581.6	557.5	24.1	106.1	103.5	2.6
1960	5.6	509.4	491.5	17.9	606.5	576.3	30.2	107.9	105.1	2.8
1961	6.7	533.0	498.4	34.6	631.2	593.1	38.1	109.7	103.5	6.2
1962	5.6	556.5	528.7	27.8	659.3	614.5	44.8	110.9	106.3	4.6
1963	5.7	580.9	548.3	32.6	689.1	638.1	51.0	112.4	107.0	5.4
1964	5.2	606.0	577.7	28.3	721.7	666.1	55.6	113.8	109.5	4.3
1965	4.6	632.8	612.5	20.3	754.0	695.7	58.3	115.3	112.7	2.6
1966	3.9	656.9	650.3	6.6	790.3	733.0	57.3	116.0	116.3	−.3
1967	3.8	664.3	663.8	.5	828.3	773.8	54.5	115.8	117.2	−1.4

1. Labor force concept.

Source: U.S. Department of Commerce, Office of Business Economics.

consumption will increase $1.0 billion in that year.[12] However, because both lagged disposable personal income and lagged consumption are explanatory variables in the estimating equation for personal consumption expenditures, the tax changes made in year one will have an effect on consumption of $0.2 billion in year two. The gap that remains to be closed in year two, therefore, is $0.8 billion, rather than the original $1.0 billion, and the tax cut in year two necessary to close this gap is not $1.6 billion, but 80 percent of this amount, or $1.3 billion. In year three, the tax cut made in year one continues to have a small effect on consumption through the influence of the lagged consumption variable. In addition, the $1.3 billion tax cut made in year two affects consumption in year three, through the lagged income and consumption terms. The combined effect on consumption in year three of tax cuts in years one and two is $0.27. Accordingly, we need to fill a gap of only $0.73 billion in year three, and this is accomplished by a personal tax cut of $1.2 billion.

Since not all policy instruments affect the same set of variables, the various fiscal measures differ in their impact over time. For instance in the case of corporate profits taxes, the successive tax cuts required to fill a gap of $1 billion in each of 3 consecutive years are $3.0 billion in year one, followed by $1.8 billion in year two, and $1.6 billion in year three.

Potential output

What would be the course of GNP if economic fluctuations were eliminated and full employment were steadily maintained? It is apparent from the preceding explanation that the model can provide an answer to this question which differs from other answers because it systematically allows for the fact that the supply of the factors of production depends on the unemployment rate and the level of economic activity. These variables affect the size of the labor force and (through investment) the size of the capital stock.

The model also shows that the size of the GNP that corresponds to full employment depends on the composition of full employment demand. Demand for GNP that stems from fixed business investment or from government outlays for employee compensation influences the size of the GNP which can be supplied, while demand for GNP that stems from personal consumption, residential investment, exports, and government purchases of business output does not.

In the simulation undertaken in this section, we estimate GNP on the assumption that unemployment was maintained at 4 percent throughout 1948–67 by fiscal policy measures that do not influence potential supply.[13] These include all taxes, except the corporate profits tax, and all expenditures other than for Federal employee compensation and grants-in-aid. The results of the simulation are shown in table 6. In order to minimize model errors, the effects of maintaining full employment are isolated by comparing the estimated full employment GNP, not with actual GNP, but with the GNP that the model estimated would have materialized if actual unemployment rates had prevailed.

As can be seen from the table, maintenance of a 4 percent unemployment rate would not have greatly changed the broad contours of GNP.[14] The reason for this is that economic activity was at high levels in most of the postwar years, and that serious and prolonged periods of underemployment did not occur.

Had unemployment been maintained at 4 percent throughout, GNP would have grown at 3.9 percent per year, 0.1 percent faster than the model estimate of GNP growth at actual levels of unemployment. The improved growth performance would have been due entirely to a faster growth in the stock of capital; the long-term increase in labor input is not changed by the maintenance of a 4 percent unemployment rate.

Over the period as a whole, GNP would have been $189 billion higher in 1958 dollars. This would have been a gain over actual output of 2 percent. As can be seen from the table, GNP would actually have been lower in the first half of the period because employment as measured by the 4 percent unemployment yardstick was overfull. Shortfalls of actual from full employment GNP are concentrated in the second postwar decade with the maximum loss of GNP of $35 billion—or about 7 percent—occurring in 1961.

12. Actually the impact on personal demand is not solely on consumption. There are also minor impacts on imports and residential investment. For the sake of simplicity, the effects of the import and residential investment equations have been ignored in this explanation.

13. All other exogenous variables needed for this simulation are inserted in the model at their actual 1948–67 values, except for price inflators which are subject to marked cyclical variations. In the absence of specific information bearing on this point, prices are assumed to increase at the actual average annual rate for this period—2.3 percent per year.

14. It should be noted that this simulation may not adequately reflect the changes in GNP resulting from maintaining full employment because it does not allow for changes in the rates of technical progress induced by the elimination of economic fluctuations.

(Continued from page 16)

Amount of inventory imbalance

In both this and the preceding survey, manufacturers who classified their stocks as "high" or "low" were asked to estimate the amount by which their inventories were out of balance.

As noted above, manufacturers holding 22 percent of producers' stocks designated their March 31 inventories as either "high" or "low." The net excess on March 31 reported by these manufacturers was quite modest—$1.7 billion, or less than 2 percent of total book value of manufacturers' stocks. This was not significantly different from the $1.5 billion excess reported at the end of 1968 (see text table p. 15).

Inventory imbalances were reported primarily by durable goods producers. Their excess rose from $1 billion on December 31 last year to $1.2 billion, or 2 percent of book value, on March 31. Excess inventories held by nondurable goods producers continued to be estimated at $½ billion, or 1.6 percent of stocks.

A tabulation of all companies reporting imbalances indicates that the average (mean) amount of imbalance was 11 percent of the book value of their inventories. About 30 percent of the companies reported imbalances of 5 percent or less, while 12 percent had imbalances of more than 20 percent.

APPENDIX—EQUATIONS, LIST OF VARIABLES, AND STATISTICAL TERMS

Supply Equations and Identities [1]

(1) Labor force participation, 1947–65

Males

$$\frac{L_m}{P_m}t = \underset{(91.81)}{-239.68} + \underset{(219.83)}{854.08}\frac{EM}{P_m}t - \underset{(139.1)}{570.7}\left(\frac{EM}{P_m}t\right)^2 - \underset{(3.266)}{15.770}\ \ln T_t^{46} - \underset{(0.0474)}{0.1710}\ \%\Delta E_{c_t};$$

OLS.

Females

$$\frac{L_f}{P_f}t = -\underset{(14.695)}{60.527} - \underset{(11.98)}{25.63}\frac{EF}{P_f}t + \underset{(3.930)}{15.209}\ \ln T_t^{46} - \underset{(0.0368)}{0.0744}\ \%\Delta E_{c_t};$$

OLS.

(2) State and local government employment per capita, 1947–65 [3]

$$\frac{E_s}{P}t = \underset{(0.00163)}{0.002389} + \underset{(0.001492)}{0.003241}\frac{GNP_p}{P}t-1 + \underset{(0.0310)}{0.1761}\frac{GAC}{P}t + \underset{(0.0172)}{0.06568}\frac{S}{P}t;$$

$\bar{R}^2=0.99$ $D.W.=1.35$ $d.f.=15$ $S_e=0.005$ TSLS.

(3) Average annual hours per private employee, 1948–65

$$MH_t = \underset{(10.3)}{2301.5} - \underset{(1.925)}{11.229}\ UR_t - \underset{(0.898)}{15.980}\ T_t^{46} + \underset{(1.475)}{11.552}\ T_t^{57};$$

$\bar{R}^2=0.99$ $D.W.=1.98$ $d.f.=14$ $S_e=8.11$ OLS.

(4) Investment in producers' durable equipment, 1948–65 (constant dollars)

$$I_{e_t} = -\underset{(1.51)}{6.19} + \underset{(0.0199)}{0.0451}\ GNP_{p_t} - \underset{(0.0227)}{0.0455}\ K_{e_{t-1}} + \underset{(0.061)}{0.312}\ IF_t$$

$$+\underset{(42.70)}{116.22}\left(\frac{1}{UR}t\right)\left(\frac{IF}{K}t-1\right) + \underset{(0.0850)}{0.3369}\ I_{e_{t-1}};$$

$\bar{R}^2=0.98$ $D.W.=1.97$ $d.f.=12$ $S_e=0.67$ TSLS.

(5) Investment in nonresidential structures, 1947–65 (constant dollars)

$$I_{s_t} = -\underset{(3.08)}{2.79} + \underset{(0.0052)}{0.0194}\ GNP_{p_t} + \underset{(23.776)}{32.153}\ \frac{IF}{K}t-1 + \underset{(0.1735)}{0.5146}\ I_{s_{t-1}};$$

$\bar{R}^2=0.90$ $D.W.=1.29$ $d.f.=15$ $S_e=0.83$ TSLS.

1. Where the dependent variable is in current (constant) dollars, all independent variables (expressed in value terms) are also measure in current (constant) dollars. Equations 9, 10, 24, and 25 are exceptions.

2. These equations were originally estimated in a reduced form with unemployment over population as the dependent variable rather than labor force over population. Error terms are available only for the reduced form equations.

3. Private GNP in this equation is measured in 1958 prices.

(6) Gross flow of corporate funds, 1948–65 (current dollars)

$$CPCCA_{c_t} = -\underset{(3.7943)}{3.6723} - \underset{(0.6638)}{1.5649}\, UR_t + \underset{(0.0090)}{0.2045}\, GNP_{p_t}$$

$$+ \underset{(0.3997)}{1.3852} \sum_{i=0}^{t} [D_{ps_i} - UL_i];$$

$$\bar{R}^2 = 0.98 \quad D.W. = 1.71 \quad d.f. = 14 \quad S_e = 2.96 \quad \text{TSLS.}$$

(7) Corporate capital consumption allowances,[4] 1947–65 (constant dollars)

$$CCA_{c_t} = -\underset{(1.450)}{10.993} + \underset{(0.0036)}{0.0569}\, K_{t-1} + \underset{(0.0010)}{0.0045}\, K_{t-1}^{54} + \underset{(0.0006)}{0.0050}\, K_{t-1}^{62};$$

$$\bar{R}^2 = 0.99 \quad D.W. = 1.75 \quad d.f. = 15 \quad S_e = 0.46 \quad \text{OLS.}$$

(8) Federal corporate profit taxes, 1947–65 (current dollars)

$$CPT_{f_t} = \underset{(0.6479)}{2.1276} + \underset{(0.0263)}{0.7381}\, [(TR_c)\,(CP)]_t;$$

$$\bar{R}^2 = 0.98 \quad D.W. = 1.64 \quad d.f. = 17 \quad S_e = 0.74 \quad \text{TSLS.}$$

(9) Corporate profits (book value) before taxes (current dollars)

$$CP_t = CPCCA_{c_t} - (CCA_{c_t})\,(DF_{I_t}).$$

(10) Corporate internal funds (constant dollars)

$$IF_t = (CPCCA_{c_t} - CPT_{f_t} - CPT_{s_t}) / DF_{I_t}.$$

(11) Production function, 1929–65 (constant dollars)

$$GNP_{p_t} = e^{a+b(UR)^2} A e^{aT^{29}} [K_{x_1}(t)^{1-\lambda} [(MH)(E_p)]_{x_2}(t)^{\lambda}].$$

In the estimating form:

$$\ln \frac{GNP_p}{K_{04}}\, t = \underset{(0.0159)}{0.6048} - \underset{(0.000030)}{0.000269}(UR_t)^2 + \underset{(0.00122)}{0.01167}\, T_t^{29} + \underset{(0.0262)}{0.8304}\, \ln \frac{[(MH)(E_p)]_{t}}{K_{04}}\, t;$$

$$\bar{R}^2 = 0.99 \quad D.W. = 1.35 \quad d.f. = 33 \quad S_e = 0.022 \quad \text{TSLS.}$$

(12) Gross government product (constant dollars)

$$GGP_{s_t} = 3.916 E_{s_t};$$

$$GGP_{f_t} = 3.997 E_{m_t} + 5.913 E_{f_t};$$

$$GGP_t = GGP_{s_t} + GGP_{f_t}.$$

(13) Supply-side estimate of GNP (constant dollars)

$$GNP_t^s = GGP_t + GNP_{p_t}.$$

4. This was converted to constant dollars by use of the OBE deflator for nonresidential investment (DF_I).

INCOME EQUATIONS AND IDENTITIES[1]

(14) Noncorporate capital consumption allowances,[6] 1947–65 (constant dollars)

$$CCA_{n_t} = \underset{(7.333)}{-32.575} + \underset{(0.0182)}{0.1061}\ HS_{t-1} - \underset{(0.00040)}{0.00145}\ [(HS_{t-1})(T_t^{*})];$$

$$\bar{R}^2=0.98 \quad D.W.=0.94 \quad d.f.=16 \quad S_e=0.46 \quad OLS.$$

(15) State and local indirect business taxes, 1947–65 (current dollars)

$$IBT_{s_t} = \underset{(1.027)}{-10.507} + \underset{(0.00254)}{0.09198}\ GNP_{p_t};$$

$$\bar{R}^2=0.99 \quad D.W.=0.86 \quad d.f.=17 \quad S_e=1.25 \quad TSLS.$$

(16) Federal indirect business taxes, 1947–65 (current dollars)

$$IBT_{f_t} = \underset{(0.355)}{3.079} + \underset{(0.00176)}{0.01873}\ GNP_{p_t} + \underset{(0.00247)}{0.00798}\ [(TR_e)(MF)]_t + \underset{(0.1770)}{0.5592}\ D_k;$$

$$\bar{R}^2=0.99 \quad D.W.=2.09 \quad d.f.=15 \quad S_e=0.26 \quad \text{TSLS.}$$

(17) Contributions for State and local social insurance, 1948–65 (current dollars)

$$SIC_{s_t} = \underset{(0.0479)}{0.0074} + \underset{(0.0151)}{0.0294}\left[CE_t - \frac{(E_s)}{E}(SIC_s)\right]_t + \underset{(0.120)}{0.8261} SIC_{s_{t-1}};$$

$$\bar{R}^2=0.99 \quad D.W.=2.40 \quad d.f.=15 \quad S_e=0.034 \quad \text{TSLS.}$$

(18) Social insurance contributions for OASDHI, 1947–65 (current dollars)

$$SIC_{o_t} = \underset{(0.1927)}{-0.4052} + \underset{(0.0199)}{1.0101}\left[(TR_o)(C_o)\left(\frac{WB_o}{MFI}\right)(CE-SIC_s)\right]_t;$$

$$\bar{R}^2=0.99 \quad D.W.=0.82 \quad d.f.=17 \quad S_e=0.45 \quad \text{TSLS.}$$

(19) Unemployment insurance contributions, 1947–65 (current dollars)

$$SIC_{u_t} = \underset{(0.1416)}{0.5158} + \underset{(0.0313)}{0.4208}\ [(TR_u)(CE-SIC_s)]_t;$$

$$\bar{R}^2=0.90 \quad D.W.=1.95 \quad d.f.=17 \quad S_e=0.29 \quad \text{TSLS.}$$

(20) Compensation of employees, 1947–65 (current dollars)

$$CE_t = \underset{(1.34)}{-29.07} + \underset{(0.0044)}{0.9261}\ (PI-D-IP-TP)_t;$$

$$\bar{R}^2=0.99 \quad D.W.=2.81 \quad d.f.=16 \quad S_e=1.57 \quad \text{TSLS.}$$

6. This was converted to constant dollars by use of the OBE deflator for residential investment (DF_{r_t}).

(21) Employer contributions for social insurance, 1947–65 (current dollars)

$$SIC_{e_t} = \underset{(0.3626)}{0.5081} + \underset{(0.0570)}{0.4834}\, SIC_t + \underset{(0.00258)}{0.00293}\, [(SIC)(T^{q})]_t;$$

$$\bar{R}^2 = 0.99 \quad D.W. = 0.99 \quad d.f. = 16 \quad S_e = 0.23 \quad \text{TSLS.}$$

(22) Consumer interest payments, 1947–65 (current dollars)

$$IP_{c_t} = -\underset{(0.1539)}{4.5581} + \underset{(0.00044)}{0.02927}\, PI_t;$$

$$\bar{R}^2 = 0.99 \quad D.W. = 1.22 \quad d.f. = 17 \quad S_e = 0.19 \quad \text{TSLS.}$$

(23) Federal interest payments, 1947–65 (current dollars)

$$IP_{f_t} = \underset{(0.2927)}{0.4612} + \underset{(0.000801)}{0.001889}\, [(i_4)(D_f)]_t + \underset{(0.0005)}{0.8047}\, IP_{f_{t-1}};$$

$$\bar{R}^2 = 0.97 \quad D.W. = 2.54 \quad d.f. = 16 \quad S_e = 0.23 \quad \text{OLS.}$$

(24) Dividends, 1946–65 (current dollars)

$$D_t = \underset{(0.2954)}{0.5320} + \underset{(0.0347)}{0.9550}\, D_{t-1} + \underset{(0.0417)}{0.1690}\, [(IF - I_s - I_c)(DF_i)]_t;$$

$$\bar{R}^2 = 0.99 \quad D.W. = 2.40 \quad d.f. = 17 \quad S_e = 0.40 \quad \text{TSLS.}$$

(25) Personal income (current dollars)

$$PI_t = (GNP_t^c)(DF_{gnp_t}) - CCA_t - IBT_t + SE_t - (CP_t + IVA_t) - SIC_t + TP_t + IP_t + D_t.$$

(26) Median family income, 1947–65 (current dollars)

$$\ln MFI_t = \underset{(0.0585)}{3.1738} + \underset{(0.3163)}{0.7895}\, \ln ER_t + \underset{(0.0171)}{1.0936}\, \ln \frac{GNP}{E}_t + \underset{(0.1987)}{1.3498}\, \ln \frac{PI + SIC - SIC_e}{GNP}_t;$$

$$\bar{R}^2 = 0.99 \quad D.W. = 2.40 \quad d.f. = 15 \quad S_e = 0.013 \quad \text{TSLS.}$$

(27) State and local personal taxes, 1947–65 (current dollars)

$$PT_{s_t} = -\underset{(0.5805)}{0.9543} + \underset{(0.003612)}{0.006239}\, PI_t - \underset{(0.03559)}{0.06514}\, T_t^{v} + \underset{(0.0964)}{1.0093}\, PT_{s_{t-1}};$$

$$\bar{R}^2 = 0.99 \quad D.W. = 2.65 \quad d.f. = 15 \quad S_e = 0.18 \quad \text{TSLS.}$$

(28) Federal personal taxes, 1947–65 (current dollars)

$$PT_{f_t} = -\underset{(1.303)}{3.534} + \underset{(0.00972)}{0.07289}\, PI_t + \underset{(0.0413)}{0.1854}\, [(TR_{mf})(PI)]_t;$$

$$\bar{R}^2 = 0.98 \quad D.W. = 2.03 \quad d.f. = 16 \quad S_e = 1.60 \quad TSLS.$$

DEMAND EQUATIONS AND IDENTITIES

(29) Personal consumption expenditures, 1929–40, 1946–65 (constant dollars)

$$PCE_t = 1.5229 + \underset{(0.1859)}{0.4953}\ DPI_{t-1} + \underset{(0.2949)}{0.6600}\ \Delta DPI_t + \underset{(0.2105)}{0.4676}\ PCE_{t-1};$$
$$(2.7222)$$

$$\bar{R}^2=0.99 \quad D.W.=2.18 \quad d.f.=27 \quad S_e=3.87 \quad TSLS.$$

(30) Investment in residential structures, 1929–40, 1946–65 (constant dollars)

$$I_{r_t} = \underset{(4.6342)}{-24.237} - \underset{(0.718)}{4.6328}\ i_{3-5_t} + \underset{(4.23)}{7.052}\ \frac{DPI}{P}t + \underset{(0.2300)}{0.9437}\ H_t$$

$$- \underset{(1.3635)}{2.6284}\ D_k - \underset{(2.1936)}{3.3270}\ D_{56-58};$$

$$\bar{R}^2=0.96 \quad D.W.=1.24 \quad d.f.=25 \quad S_e=1.56 \quad TSLS.$$

(31) Change in business inventories, 1947–65 (constant dollars)

$$\Delta IV_t = \underset{(6.990)}{-29.943} + \underset{(0.0337)}{0.1321}\ GNP_{p_t} - \underset{(0.1227)}{0.9930}\ IV_{t-1} + \underset{(10.470)}{40.644}\ \frac{1}{UR}t + \underset{(0.6945)}{1.7183}\ T_t^{**};$$

$$\bar{R}^2=0.85 \quad D.W.=2.44 \quad d.f.=14 \quad S_e=1.44 \quad TSLS.$$

(32) Imports of goods and services, 1947–65 (constant dollars)

$$M_t = \underset{(1.409)}{-10.201} - \underset{(4.3317)}{5.9931}\ \Delta PR_t + \underset{(0.0058)}{0.09661}\ DPI_{t-1} + \underset{(0.0472)}{0.0791}\ \Delta DPI_t;$$

$$\bar{R}^2=0.98 \quad D.W.=2.66 \quad d.f.=15 \quad S_e=0.87 \quad TSLS.$$

(33) State and local government purchases of goods and services per capita (excluding compensation), 1947–65 (constant dollars)

$$\frac{G_s}{P}t = \underset{(0.018578)}{-0.10494} + \underset{(0.01703)}{0.02601}\ \frac{GNP_2}{P}t-1 + \underset{(0.1967)}{0.5567}\ \frac{S}{P}t + \underset{(0.3970)}{0.3543}\ \frac{GAC}{P}t;$$

$$\bar{R}^2=0.95 \quad D.W.=1.01 \quad d.f.=15 \quad S_e=0.05 \quad \text{TSLS.}$$

(34) Demand-side estimate of GNP (constant dollars)

$$GNP_t^d = PCE_t + I_{p_t} + I_{e_t} + I_{r_t} + \Delta IV_t + EX_t - M_t + G_{s_t} + G_{f_t} + GGP_t.$$

List of Variables

$*C_o$ = Ratio of total number of employees with OASDHI coverage to total number of paid employees (including self-employed starting 1951).
CCA_c = Corporate capital consumption allowances.
CCA_n = Noncorporate capital consumption allowances.
CE = Compensation of employees—total.

NOTE.—Unless otherwise specified all variables are measured in billions of dollars. Exogenous variables are indicated by *. All other variables are determined from equations or identities. Simple identities are included in the list of variables rather than shown in the sections on equations and identities.

CE_f = Compensation of Federal employees ($GGP_f \cdot DF_f$).
CE_p = Compensation of employees—private ($CE - CE_f - CE_s$).
CE_s = Compensation of State and local employees ($GGP_s \cdot DF_s$).
CP = Corporate profits (book value) before taxes.
$CPCCA_c$ = Corporate profits (book value) plus corporate capital consumption allowances.
CPT_f = Federal corporate profits taxes.
$*CPT_s$ = State and local corporate profits taxes.
D = Net corporate dividend payments.
$*D_f$ = Publicly held Federal debt.
$*D_k$ = Dummy variable for Korean war.
$*D_{30-50}$ = Dummy variable for 1930–50.
$*D_{pb}$ = Percent change in private business GNP deflator (1958=100).
$*DF_f$ = Deflator for compensation of Federal employees (1958=100).
$*DF_{gnp}$ = Deflator for total GNP (1958=100).
$*DF_i$ = Deflator for nonresidential fixed investment (1958=100).
$*DF_{rs}$ = Deflator for residential structures (1958=100).
$*DF_s$ = Deflator for compensation of State and local employees (1958=100).
DPI = Disposable personal income ($PI - PT_f - PT_s$).
E = Total number of employees ($E_c + E_m$) (millions).
E_c = Total number of civilian employees ($L_c \cdot ER$) (millions).
$*E_f$ = Average number of full-time and part-time Federal civilian employees (millions).
$*E_m$ = Number of military employees (millions).
E_p = Number of private civilian employees ($E_c - E_f - E_s$) (millions).
E_s = Average number of full-time and part-time State and local employees (millions).
EF = Number of females employed (millions).
EM = Number of males employed (millions).
ER = Employment rate ($100.0 - UR$) (percent).
$*EX$ = Exports of goods and services.
$*G_f$ = Federal Government purchases of goods and services excluding compensation of employees.
G_s = State and local government purchases of goods and services excluding compensation of employees.
$*GAC$ = Federal Government grants-in-aid to State and local government deflated by OBE deflator for State and local government purchases.
GGP = Gross government product—total.
GGP_f = Gross government product—Federal.
GGP_s = Gross government product—State and local.
GNP = Gross national product.
GNP^d = Demand estimate of gross national product.
GNP^s = Supply estimate of gross national product.
GNP_p = Private gross national product.
$*H$ = Number of households (millions).
$*HS$ = Stock of nonfarm residential structures (1958 prices).
$*i_3$ = Yield on 3-month government bills (percent).
$*i_{3-5}$ = Yield on 3–5 year taxable government issues, starting in 1951 (percent).
I_e = Private purchases of producers' durable equipment.
I_r = Private purchases of residential structures.
I_s = Private purchases of nonresidential structures.
IBT_f = Federal Government indirect business taxes and nontaxes.
IBT_s = State and local government indirect business taxes and nontaxes.
IF = Internal funds.
IP = Total interest payments.

IP_c =Interest paid by consumers.
IP_f =Net interest paid by Federal Government.
*IP_s =Net interest paid by State and local government.
*IV =Stock of business inventories.
*IVA =Inventory valuation adjustment.
*K =Total stocks of capital: OBE gross stocks of equipment and structures, constant cost 2 estimates, as published in the February 1967 SURVEY.
*K^{54} =Total capital stocks starting in 1954.
*K^{62} =Total capital stocks starting in 1962.
*K_e =Gross stocks of equipment.
*K_{et} =Total capital stocks adjusted for 4 percent rate of embodied technical progress and adjusted by the employment rate.
L =Labor force (millions).
L_c =Civilian labor force ($L-E_m$) (millions).
L_f =Female labor force (millions).
L_m =Male labor force (millions).
M =Imports of goods and services.
*MF =Motor fuel usage (billions of gallons).
MFI =Median family income (dollars).
MH =Average annual hours worked per employee in private economy (labor force concept).
*OM =Index of output per man-hour (1957–59=100) (labor force basis).
*P =Total population (millions).
*P_f =Female population, 14 years of age and over (millions).
*P_m =Male population, 14 years of age and over (millions).
PCE =Personal consumption expenditures.
PI =Personal income.
*PR =Import deflator/PCE deflator.
PT_f =Federal personal taxes.
PT_s =State and local personal taxes.
*S =School enrollment (millions).
*SE =Subsidies less current surplus of government enterprises.
SIC =Total contributions for social insurance ($SIC_f+SIC_o+SIC_s+SIC_u$).
SIC_e =Employer contributions for social insurance.
*SIC_f =Contributions for other Federal social insurance programs.
SIC_o =Employer, employee and self-employed contributions for old-age and survivors insurance (OASDHI).
SIC_s =Total contributions for State and local social insurance programs.
SIC_u =Social insurance contributions for unemployment insurance.
*T^{28} =Time trend (1928=0).
*T^{45} =Time trend (1945=0).
*T^{46} =Time trend (1946=0).
*T^{56} =Time trend (1956=0).
TH =Index of total man-hours in private sector ($MH \cdot E_o$) (1929=100).
*TP =Government transfer payments to persons.
*TR_c =Federal corporate profits tax rate (ratio).
*TR_g =Federal tax rate on gasoline (cents per gallon).
*TR_{mfi} =Federal tax rate for the median family income (ratio).
*TR_o =Employee-employer combined contribution rate for OASDHI (ratio).
*TR_u =Average employer contribution rate for unemployment insurance (ratio).
*UL =Percent change in unit labor costs $\left(\%\Delta\frac{CE_o}{TH}-\%\Delta OM\right)$.
*UR =Unemployment rate (percent).
*WB_o =Maximum earnings taxable and creditable (wage base) for OASDHI (dollars).
*X_1 =Rate of embodied technical progress in capital (percent).
*X_2 =Rate of embodied technical progress in labor (percent).

List of Statistical Terms

OLS =Ordinary least-squares estimate.
$TSLS$ =Two-stage least-squares estimate.
$D.W.$ =Durbin-Watson statistic: Test for serial correlation of residuals.
$\bar{R}^2$ =Adjusted coefficient of determination.
$d.f.$ =Degrees of freedom.
S_e =Standard error of estimate.
ln =Natural logarithm.